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A species checklist of the subgenus *Culicoides* (*Avaritia*) in China, with a description of a new species (Diptera, Ceratopogonidae)

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Abstract

A checklist of the subgenus *Culicoides* (*Avaritia* Fox) (Diptera: Ceratopogonidae: *Culicoides*) in China, currently including 57 species, is provided. Their full citations, more detailed locations of the type locality, and distribution of each species by province, and/or state of each species are also provided. *Culicoides* (*Avaritia*) *fenggangensis* Liu & Hou, **sp. n.** is described and illustrated, based on both male and female specimens from China. The new species is compared with its similar congeners, *C.* (*A.*) *comparis* Liu & Yu, 2005 and *C.* (*A.*) *dentiformis* McDonald & Lu, 1972.

Keywords

Biting midges, Ceratopogonidae, checklist, *Culicoides*, subgenus *Avaritia*

Introduction

Biting midges of the genus *Culicoides* Latreille (Diptera, Ceratopogonidae) are found everywhere in the world and females are the smallest of insect vectors (Mellor et al. 2000). Some species of *Culicoides* spread disease in humans and livestock as vectors of arboviruses, such as bluetongue virus (BTV), Schmallenberg virus (SBV), and others (Borkent

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2005), which leads to direct economic costs for agriculture (Gibbens 2012; Velthuis et al. 2010). In China, Bluetongue has been recorded from several provinces in south, such as Yunnan, Hubei, Anhui, Sichuan, Shanxi and so on (Zhang et al. 2015), and the vector *Culicoides* of BTV mainly distributed in the south region of north latitude 40° (Zhang et al. 2014). Therefore, members of this genus have great international significance and have attracted more scientific attention in recent years. The genus *Culicoides*, currently with a total number of species of 1415 in the world, 1368 extant species and 47 fossil species (Borkent, 2016), has 348 species in China. Many of the important vectors are in the subgenus *Culicoides* (*Avaritia* Fox). The purpose of this paper is to provide a checklist of this subgenus in China, and describe and illustrate *Culicoides* (*A.*) *fenggangensis* sp. n.

Materials and methods

The specimens were collected with light traps near households in the mountains of Fenggang County of Guizhou Province. For microscopic observation, specimens were preserved in 100% ethanol and then slide-mounted in Canada balsam following the technique described by Yu et al. (2005). Diagnostic features were microphotographed using an Imaging System of Upright Research Microscope adapted to a microscope (Nikon Eclipse Ni-E) and a Digital System of Large depth-of-field 3D Digital Microscope (Keyence VHX-1000C), and Photoshop CS4 was used to obtain the final images. Morphological terms are from the chapter on Ceratopogonidae by Yu et al. (2005). Terms of structures specific to *Culicoides* follow those described by Santarém et al. (2014) and Han et al. (2017). Measurements of wings, flagellar segments, palpus, and legs are given in millimeters, and measurements of spermathecae are given in microns. Meristic information is presented as ranges of values, followed by mean and sample size. The type specimens are deposited in Insect Collection of Zunyi Medical University, Guizhou Province, China.

Taxonomy

Checklist of the subgenus *Avaritia* in China in alphabetical order

Subgenus *Avaritia* Fox, 1955
Avaritia Fox, 1955: 218.
Type species. *Ceratopogon obsoletus* Meigen, 1818.

***Culicoides* (*Avaritia*) *abchazicus* Dzhafarov, 1964**
Culicoides abchazicus Dzhafarov, 1964: 263; Liu et al. 2011: 385. Type Locality: Georgia.
Distribution. China (Liaoning); Georgia.

***Culicoides* (*Avaritia*) *actoni* Smith, 1929**

Culicoides actoni Smith, 1929: 255; McDonald and Lu 1972: 411; Lee 1988: 29; Yu et al. 2005: 907. Type locality: India.

Culicoides okumensis Arnaud, 1956: 119. Type locality: Japan.

Culicoides imperceptus Das Gupta, 1962a: 538. Type locality: India.

Distribution. China (Heilongjiang, Jiangsu, Anhui, Fujian, Taiwan, Shandong, Hubei, Guangdong, Guangxi, Hainan, Sichuan, Yunnan, Tibet, Shaanxi, Hunan); India, Indonesia, Malaysia, Philippines, Vietnam, Japan, Thailand.

***Culicoides* (*Avaritia*) *albifascia* Tokunaga, 1937**

Culicoides albifascia Tokunaga, 1937: 319; Lee 1978: 28; Yu et al. 2005: 908. Type locality: China: Taiwan.

Distribution. China (Heilongjiang, Tibet, Sichuan, Yunnan, Taiwan).

***Culicoides* (*Avaritia*) *bawanglingensis* Yu, Wang & Chen, 2012**

Culicoides bawanglingensis Yu, Wang & Chen, in Wang et al., 2012: 283. Type Locality: China: Hainan, Bawangling.

Distribution. China (Hainan).

***Culicoides* (*Avaritia*) *brevipalpis* Delfinado, 1961**

Culicoides brevipalpis Delfinado, 1961: 654; Yu et al. 2005: 910. Type locality: Philippines.

Distribution. China (Taiwan, Guangdong, Hainan, Yunnan); Australia, Indonesia, Malaysia, Japan, Sri Lanka, Thailand, Philippines.

***Culicoides* (*Avaritia*) *brevitarsis* Kieffer, 1917**

Culicoides brevitarsis Kieffer, 1917: 187; Yu et al. 2005: 911. Type locality: Australia.

Culicoides robertsi Lee & Reye, 1953: 386. Type locality: Australia.

Culicoides radicitus Delfinado, 1961: 657. Type locality: Philippines.

Culicoides superfulvus Das Gupta, 1962b: 253. Type locality: India.

Distribution. China (Anhui, Taiwan, Hainan); Australia, Philippines, India, Laos, Malaysia.

***Culicoides* (*Avaritia*) *bubalus* Delfinado, 1961**

Culicoides bubalus Delfinado, 1961: 658; Yu et al. 2005: 913. Type locality: The Philippines.

Distribution. China (Taiwan), Philippines.

***Culicoides* (*Avaritia*) *chiopterus* (Meigen), 1830**

Ceratopogon chiopterus Meigen, 1830: 263. Type locality: Europe.
Ceratopogon amoenus Winnertz, 1852: 35. Type locality: Germany.
Monohelea similis Goetghebuer, 1927: 203. Type locality: Belgium.
Culicoides dobyi Callot & Kremer, 1969: 610. Type locality: France.
Distribution. China (Hebei, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Tibet); Germany, France, Belgium, Britain, Russia.

***Culicoides* (*Avaritia*) *clavipalpis* Mukerji, 1931**

Culicoides clavipalpis Mukerji, 1931: 1052; McDonald and Lu 1972: 403; Yu et al. 2005: 916. Type locality: India.
Culicoides candidus Sen & Das Gupta, 1959: 620. Type locality: India.
Distribution. China (Jiangsu, Fujian, Shandong, Hainan, Sichuan); India, Indonesia, Laos, Malaysia, Philippines, Thailand.

***Culicoides* (*Avaritia*) *comparis* Liu & Yu, 2005**

Culicoides comparis Liu & Yu, in Yu et al., 2005: 917. Type locality: China: Tibet, Nielamu.
Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *conaensis* Liu & Yu, 1990**

Culicoides conaensis Liu & Yu, 1990: 19; Yu et al. 2005: 919. Type locality: China: Tibet, Cuona.
Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *dentiformis* McDonald & Lu, 1972**

Culicoides dentiformis McDonald & Lu, 1972: 403; Yu et al. 2005: 921. Type locality: China: Taiwan.
Distribution. China (Taiwan).

***Culicoides* (*Avaritia*) *elongatus* Chu & Liu, 1978**

Culicoides elongatus Chu & Liu, 1978: 83; Yu et al. 2005: 922. Type locality: China: Yunnan, Mengla.
Distribution. China (Fujian, Yunnan).

***Culicoides* (*Avaritia*) *fenggangensis* Liu & Hou, sp. n.**

Culicoides fenggangensis Liu & Hou, sp. n., this paper. Type locality: China: Guizhou, Fenggang.

Distribution. China (Guizhou).

***Culicoides* (*Avaritia*) *filicinus* Gornostaeva & Gachegova, 1972**

Culicoides filicinus Gornostaeva & Gachegova, 1972: 522; Yu et al. 2005: 924. Type locality: Russia.

Distribution. China (Tibet, Heilongjiang); Russia.

***Culicoides* (*Avaritia*) *gaponus* Yu, 1982**

Culicoides gaponus Yu, 1982: 202; Yu et al. 2005: 925. Type locality: China: Hainan, Diaoluoshan.

Distribution. China (Hainan).

***Culicoides* (*Avaritia*) *holcus* Lee, 1980**

Culicoides holcus Lee, 1980: 85; Yu et al. 2005: 927. Type locality: China: Yunnan.

Distribution. China (Yunnan).

***Culicoides* (*Avaritia*) *hui* Wirth & Hubert, 1961**

Culicoides hui Wirth & Hubert, 1961: 16; Yu et al. 2005: 928. Type locality: China: Taiwan.

Distribution. China (Taiwan, Guangdong, Hainan, Yunnan, Hunan); Indonesia, Laos, Malaysia.

***Culicoides* (*Avaritia*) *imicola* Kieffer, 1913**

Culicoides imicola Kieffer, 1913: 11; Yu et al. 2005: 930. Type locality: Kenya.
Culicoides pallidipennis Carter, Ingram & Macfie, 1920: 265. Type locality: Ghana.
Culicoides iraqensis Khalaf, 1957: 343. Type locality: Iraq.
Culicoides minutus Sen & Das Gupta, 1959: 622. Type locality: India.
Culicoides pseudoturgidus Das Gupta, 1962a: 537. Type locality: India.

Distribution. China (Hainan); Wide spread in Africa, the Middle and Far East, India, Laos, Sri Lanka, Vietnam.

***Culicoides* (*Avaritia*) *incertus* Yu & Zhang, 1988**

Culicoides incertus Yu & Zhang, in Yu, 1988: 136; Yu et al. 2005: 931. Type locality: China: Tibet.

Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *innoxius* Sen & Das Gupta, 1959**

Culicoides innoxius Sen & Das Gupta, 1959: 626; Yu et al. 2005: 933. Type locality: India.

Distribution. China (Hainan); India, Cambodia, Indonesia, Laos, Malaysia, Sri Lanka, Thailand.

***Culicoides* (*Avaritia*) *insignipennis* Macfie, 1937**

Culicoides insignipennis Macfie, 1937b: 469; Lee 1988: 65; Yu et al. 2005: 935. Type locality: Malaysia.

Distribution. China (Fujian, Taiwan, Yunnan, Hunan); Malaysia, Brunei, Indonesia, Laos, Philippines, Singapore, Thailand.

***Culicoides* (*Avaritia*) *iphthimus* Zhou & Lee, 1984**

Culicoides iphthimus Zhou & Lee, 1984: 295; Yu et al. 2005: 936. Type locality: China: Chongqing.

Distribution. China (Chongqing).

***Culicoides* (*Avaritia*) *jacobsoni* Macfie, 1934**

Culicoides jacobsoni Macfie, 1934: 215; Yu 1982: 48. Yu et al. 2005: 938. Type locality: Indonesia.

Culicoides buckleyi Macfie, 1937a: 117. Type locality: Malaysia.

Culicoides kitaokai Tokunaga, 1955: 6. Type locality: Japan.

Culicoides unisetiferus Tokunaga, 1959: 236. Type locality: Papua New Guinea.

Distribution. China (Fujian, Taiwan, Guangdong, Guangxi, Hainan, Yunnan, Tibet, Hunan); Indonesia, Malaysia, Japan, New Guinea, Philippines, Thailand.

***Culicoides* (*Avaritia*) *kepongensis* Lee, 1988**

Culicoides kepongensis Lee, 1988: 69; Wirth and Hubert 1989: 346; Yu et al. 2005: 940. Type locality: China; Malaysia.

Distribution. China (Fujian, Taiwan); Malaysia, Laos, Thailand.

***Culicoides* (*Avaritia*) *kinabaluensis* Wirth & Hubert, 1989**

Culicoides kinabaluensis Wirth & Hubert, 1989: 211; Yu et al. 2005: 941. Type locality: Indonesia.

Distribution. China (Hainan).

***Culicoides* (*Avaritia*) *lansangensis* Howarth, 1985**

Culicoides lansangensis Howarth, 1985: 58; Liu et al. 1996: 38; Yu et al. 2005: 942. Type locality: Laos.

Distribution. China (Guangdong, Hainan, Hunan).

***Culicoides* (*Avaritia*) *lengi* Yu & Liu, 1990**

Culicoides lengi Yu & Liu, 1990: 10; Yu et al. 2005: 944. Type locality: China: Guangdong, Shixing.

Distribution. China (Guangdong).

***Culicoides* (*Avaritia*) *liui* Wirth & Hubert, 1961**

Culicoides liui Wirth & Hubert, 1961: 20; Yu et al. 2005: 946. Type locality: China: Taiwan.

Distribution. China (Taiwan, Yunnan); Indonesia, Laos, Malaysia, Philippines, Thailand.

***Culicoides* (*Avaritia*) *longirostris* Qu & Wang, 1994**

Culicoides longirostris Qu & Wang, 1994: 486; Yu et al. 2005: 947. Type locality: China: Tibet.

Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *malayae* Macfie, 1937**

Culicoides malayae Macfie, 1937b: 471; Yu 1982: 190; Yu et al. 2005: 949. Type locality: Malaysia.

Distribution. China (Fujian, Taiwan, Guangdong, Guangxi, Hainan, Yunnan); Indonesia, Malaysia, Philippines, Thailand.

***Culicoides* (*Avaritia*) *mamaensis* Lee, 1979**

Culicoides mamaensis Lee, 1979: 101; Yu et al. 2005: 951. Type locality: China: Tibet, Cuona.

Distribution. China (Sichuan, Tibet).

***Culicoides* (*Avaritia*) *motoensis* Lee, 1978**

Culicoides motoensis Lee, 1978: 75; Yu et al. 2005: 952. Type locality: China: Tibet, Motuo.

Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *nielamensis* Liu & Deng, 2000**

Culicoides nielamensis Liu & Deng, 2000: 246; Yu et al. 2005: 954. Type locality: China: Tibet, Nielamu.

Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *nigritus* Fei & Lee, 1984**

Culicoides nigritus Fei & Lee, 1984: 345; Yu et al. 2005: 955. Type locality: China: Inner Mongolia, Linxi.

Distribution. China (Inner Mongolia).

***Culicoides* (*Avaritia*) *nujiangensis* Liu, 1990**

Culicoides nujiangensis Liu, 1990: 59; Yu et al. 2005: 956. Type locality: China: Yunnan, Nujiang.

Distribution. China (Yunnan).

***Culicoides* (*Avaritia*) *obsoletus* (Meigen), 1818**

Ceratopogon obsoletus Meigen, 1818: 76. Type locality: Europe.
Ceratopogon varius Winnertz, 1852: 35. Type locality: Germany.
Ceratopogon yezoensis Matsumura, 1911: 60. Type locality: Russia.
Culicoides obscuripes Santos Abreu, 1918: 297. Type locality: Spain.
Culicoides lacteinervis Kieffer, 1919a: 47. Type locality: Slovak Republic, Ukraine.
Culicoides rivicola Kieffer, 1921: 56. Type locality: Germany.
Culicoides clavatus Kieffer, 1921: 56. Type locality: Germany.
Culicoides heterocerus Kieffer, 1921: 57. Type locality: Germany.
Culicoides pegobius Kieffer, 1922: 235. Type locality: Germany.
Culicoides kabyliensis Kieffer, 1922: 505. Type locality: Algeria.
Culicoides concitus Kieffer, 1922: 71. Type locality: Germany.
Culicoides intermedius Okada, 1941: 22. Type locality: Japan.
Culicoides sintrensis Cambournac, 1956: 591. Type locality: Portugal.
Culicoides seimi Shevchenko, 1967: 173. Type locality: Ukraine.

Distribution. China (Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Fujian, Shandong, Sichuan, Chongqing, Yunnan, Xinjiang, Gansu, Tibet); wide distribution in Palaearctic Region, Britain, Germany, Russia, Canary Islands, Algeria, Japan, Portugal, Slovakia, Ukraine.

***Culicoides* (*Avaritia*) *orestes* Wirth & Hubert, 1989**

Culicoides orestes Wirth & Hubert, 1989: 222; Yu et al. 2005: 959. Type locality: Malaysia.

Distribution. China (Hainan); Malaysia.

***Culicoides* (*Avaritia*) *orientalis* Macfie, 1932**

Culicoides orientalis Macfie, 1932: 490; Lee 1978: 83; Yu et al. 2005: 961. Type locality: Malaysia.

Culicoides nayabazari Das Gupta, 1963: 35. Type locality: India.

Distribution. China (Fujian, Taiwan, Hainan, Sichuan, Yunnan, Tibet, Hunan); Malaysia, India, Indonesia, Philippines, Thailand, Vietnam, the Solomon Islands.

***Culicoides* (*Avaritia*) *palauensis* Tokunaga, 1959**

Culicoides palauensis Tokunaga, in Tokunaga & Murachi, 1959: 348; Yu 1982: 57; Yu et al. 2005: 963. Type locality: USA.

Distribution. China (Guangdong, Hainan, Yunnan); Oceania.

***Culicoides* (*Avaritia*) *pastus* Kitaoka, 1980**

Culicoides pastus Kitaoka, 1980: 11; Lee 1988: 91; Yu et al. 2005: 964. Type locality: Japan.

Distribution. China (Sichuan, Yunnan); Japan.

***Culicoides* (*Avaritia*) *pelius* Liu & Yu, 1990**

Culicoides pelius Liu & Yu, 1990: 23; Liu and Deng 2000: 245; Yu et al. 2005: 966. Type locality: China: Tibet, Cuona.

Distribution. China (Tibet).

***Culicoides* (*Avaritia*) *peregrinus* Kieffer, 1910**

Culicoides peregrinus Kieffer, 1910: 191; Yu et al. 2005: 967. Type locality: India.

Culicoides judicandus Bezzi, 1916: 8. Type locality: Philippines.

Culicoides esmoneti Salm, 1917b: 136. Type locality: Indonesia.

Culicoides philippinensis Kieffer, 1921: 564. Type locality: Philippines.

Culicoides assamensis Smith & Swaminath, 1932: 183. Type locality: India.

Culicoides quadratus Tokunaga, 1951: 108. Type locality: Indonesia.

Distribution. China (Hebei, Inner Mongolia, Liaoning, Jiangsu, Fujian, Taiwan, Jiangxi, Henan, Guangdong, Guangxi, Hainan); India, Philippines, Indonesia.

***Culicoides* (*Avaritia*) *qionghaiensis* Yu & Liu, 1990**

Culicoides qionghaiensis Yu & Liu, 1990: 4; Yu et al. 2005: 969. Type locality: China: Sichuan, Xichang.

Distribution. China (Sichuan).

***Culicoides* (*Avaritia*) *ruiliensis* Lee, 1980**

Culicoides ruiliensis Lee, 1980: 86; Yu et al. 2005: 971. Type locality: China: Yunnan.

Distribution. China (Yunnan).

***Culicoides* (*Avaritia*) *scoticus* Downes & Kettle, 1952**

Culicoides scoticus Downes & Kettle, 1952: 65; Yu et al. 2005: 972. Type locality: Great Britain.

Distribution. China (Tibet); Great Britain, France.

***Culicoides* (*Avaritia*) *sinanoensis* Tokunaga, 1937**

Culicoides sinanoensis Tokunaga, 1937: 331; Yu et al. 2005: 973. Type locality: Japan.

Culicoides obsoletiformis Amosova, 1957: 233. Type locality: Russia.

Distribution. China (Liaoning, Jilin, Heilongjiang, Yunnan, Shaanxi); Japan, Russia.

***Culicoides* (*Avaritia*) *suiyangensis* Hou, Han, Lv & Jiang, 2014**

Culicoides suiyangensis Hou, Han, Lv & Jiang, 2014: 98. Type Locality: China: Guizhou, Suiyang.

Distribution. China (Guizhou).

***Culicoides* (*Avaritia*) *sumatrae* Macfie, 1934**

Culicoides sumatrae Macfie, 1934: 190; Yu et al. 2005: 975. Type locality: Malaysia.

Culicoides amamiensis Tokunaga, 1937: 325. Type locality: Japan.

Culicoides kagiensis Tokunaga, 1937: 327. Type locality: Taiwan.

Culicoides ohmorii Takahashi, 1958: 113. Type locality: Japan.

Culicoides assimilis Delfinado, 1961: 660. Type locality: Philippines.

Distribution. China (Fujian, Taiwan, Guangdong, Guangxi, Hainan, Yunnan, Tibet); Malaysia, Japan, Philippines.

***Culicoides* (*Avaritia*) *suzukii* Kitaoka, 1973**

Culicoides suzukii Kitaoka, 1973: 212; Lee 1988: 107; Yu et al. 2005: 977. Type locality: Japan.

Distribution. China (Taiwan, Yunnan); Japan.

***Culicoides* (*Avaritia*) *tainanus* Kieffer, 1916**

Culicoides tainanus Kieffer, 1916: 114; Yu et al. 2005: 979. Type locality: China: Taiwan.

Ceratopogon maculatus Shiraki, 1913: 294. Type locality: China: Taiwan.
Culicoides kii Tokunaga, 1937: 284. Type locality: Japan.
Culicoides sigaensis Tokunaga, 1937: 322. Type locality: Japan.
Culicoides kyotoensis Tokunaga, 1937: 329. Type locality: Japan.
Culicoides suborientalis Tokunaga, 1951: 106. Type locality: Indonesia.
Distribution. China (Fujian, Hainan, Yunnan, Shaanxi, Shandong); Indonesia, Japan, Laos, Malaysia, Philippines, Thailand, Vietnam.

***Culicoides* (*Avaritia*) *tibetensis* Chu, 1977**
Culicoides tibetensis Chu, 1977: 102; Yu et al. 2005: 980. Type locality: China: Tibet.
Distribution. China (Sichuan, Tibet).

***Culicoides* (*Avaritia*) *trimaculatus* McDonald & Lu, 1972**
Culicoides trimaculatus McDonald & Lu, 1972: 415; Yu et al. 2005: 982. Type locality: China: Taiwan.
Distribution. China (Taiwan).

***Culicoides* (*Avaritia*) *wadai* Kitaoka, 1980**
Culicoides wadai Kitaoka, 1980: 14; Yu et al. 2005: 984. Type locality: China: Taiwan.
Distribution. China (Fujian, Guangxi, Taiwan).

***Culicoides* (*Avaritia*) *wandashanensis* Wang & Liu, 1999**
Culicoides wandashanensis Wang & Liu, 1999: 328; Yu et al. 2005: 985. Type locality: China: Heilongjiang, Raohe.
Distribution. China (Heilongjiang).

***Culicoides* (*Avaritia*) *yamii* Lien, Lin & Weng, 1998**
Culicoides yamii Lien, Lin & Weng, 1998: 57; Yu et al. 2005: 987. Type locality: China: Taiwan, Lanyu.
Distribution. China (Taiwan).

***Culicoides* (*Avaritia*) *yuchihensis* Lien, Lin & Weng, 1998**
Culicoides yuchihensis Lien, Lin & Weng, 1998: 58; Yu et al. 2005: 988. Type locality: China: Taiwan.
Distribution. China (Taiwan).

***Culicoides* (*Avaritia*) *fenggangensis* Liu & Hou, sp. n.**
http://zoobank.org/52A53C15-0F18-4040-B83C-B678BD2E9A66
Figs 1–3

Diagnosis. Male: only species of *Culicoides* in China with the following combination of features: the 3rd segment of the palpus is slender, PR 3.11; the apex of 9th tergite has lateral processes; parameres with apical portion elongate, bent abruptly; aedeagus nearly triangular, with a long ovoid process at its apex. Female: only species of *Culicoides* in China with the following combination of features: cell m_2 with four sparsely distributed pale spots; the 3rd segment of the palpus is slender, PR 3.20–3.75.

Description. Female. *Head* (Fig. 2a). Brown. Eyes (Fig. 2b) contiguous, abutting medially for length of 1.5 ommatidia, with interfacetal hairs. Antennal pedicel brown; Lengths of antennal flagellomeres in proportion of 19: 14: 14: 15: 15: 15: 16: 17: 25: 25: 25: 31: 47; AR 1.22–1.28 (1.24, n = 3); sensilla coeloconica on flagellomeres 1, 9–13. 3rd segment of palpus slender, slightly swollen at apical 1/3, with small, rounded sensory pit (Fig. 2c–d); PR 3.20–3.75 (3.45, n = 3). Mandible with 14–18 (16, n = 4) teeth (Fig. 2e); Maxilla with 17 teeth (n = 3); P/H ratio 1.04–1.17 (1.11, n = 3).

Thorax (Fig. 2f). Dark brown. Scutellum without distinct pattern in slide-mounted specimens. Wing (Fig. 1a) with contrasting pattern of pale, dark spots; distal 1/2 of 1st, proximal 1/2 of 2nd radial cell in dark spot; three pale spots near anterior margin: 1st over base of cell r_1 and r-m crossvein extending from below M_1 to margin of costa, 2nd over distal of cell r_2 from dorsal portion of M_1 to costa, 3rd morphological variation, from dorsal portion of M_1 to just below costa; cell m_1 with two separated pale spots: one spot small, ovoid, another large, triangle, far from distal portion of wing; cell m_2 with four different shapes, sizes pale spots: 1st proximal to CuA, 2nd between medial and mediocubital forks, 3rd and 4th below M_2, latter reaching wing margin; cua_1 with a large, ovoid pale spot abutting wing posterior margin; anal cell with two pale spots: proximal pale spot on Cu_2 and CuA, distal pale spot near mediocubital fork; wing base with faint pale spot on M; macrotrichia sparsely distributed on distal 1/3 of wing, but not in basal cell; wing length 1.45–1.60 (1.52, n = 3) mm, width 0.68–0.73 (0.70, n = 3) mm; CR 0.55–0.59 (0.57, n = 3). TR and F-T of legs (Fig. 2f) are given as Table 1, metatibial distal bristles (Fig. 2g–h) with 5 or 6 spines, 1st spine is longest.

Table 1. Tarsal ratios (TR) and measurements of leg segments and tarsomeres from femur to tarsomere 5 (F-T) of all legs of *C. fenggangensis* sp. n. (♀).

Leg	TR	F-T
Foreleg	2.12	85 : 88 : 53 : 25 : 16 : 10 : 11
Midleg	2.31	109 : 114 : 60 : 26 : 16 : 10 : 11
Hindleg	1.73	109 : 115 : 57 : 33 : 17 : 11 : 12

Abdomen. Brown. Two subequal-size ovoid spermathecae (Fig. 2i), measuring 65.0–72.5 × 50.0–57.5 (n = 3) μm, 65.0–72.5 × 50.0 (n = 2) μm, slender sclerotized

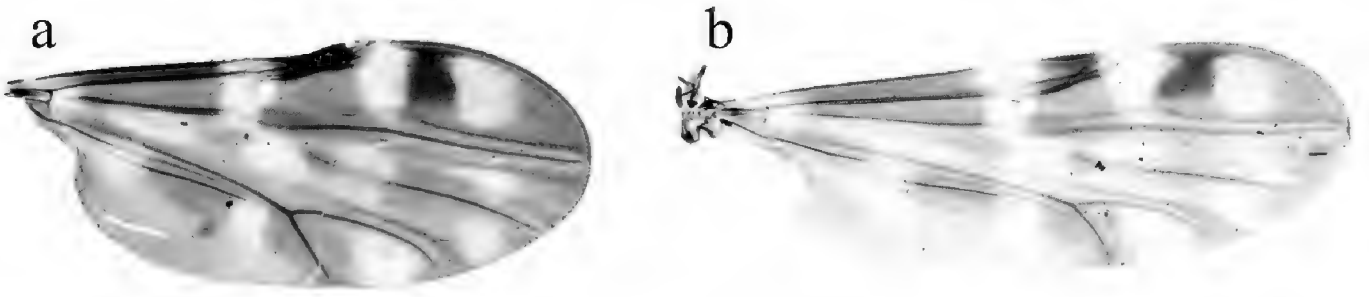

Figure 1. *Culicoides* (*A.*) *fenggangensis* sp. n. Left Wing. **a** Female **b** Male.

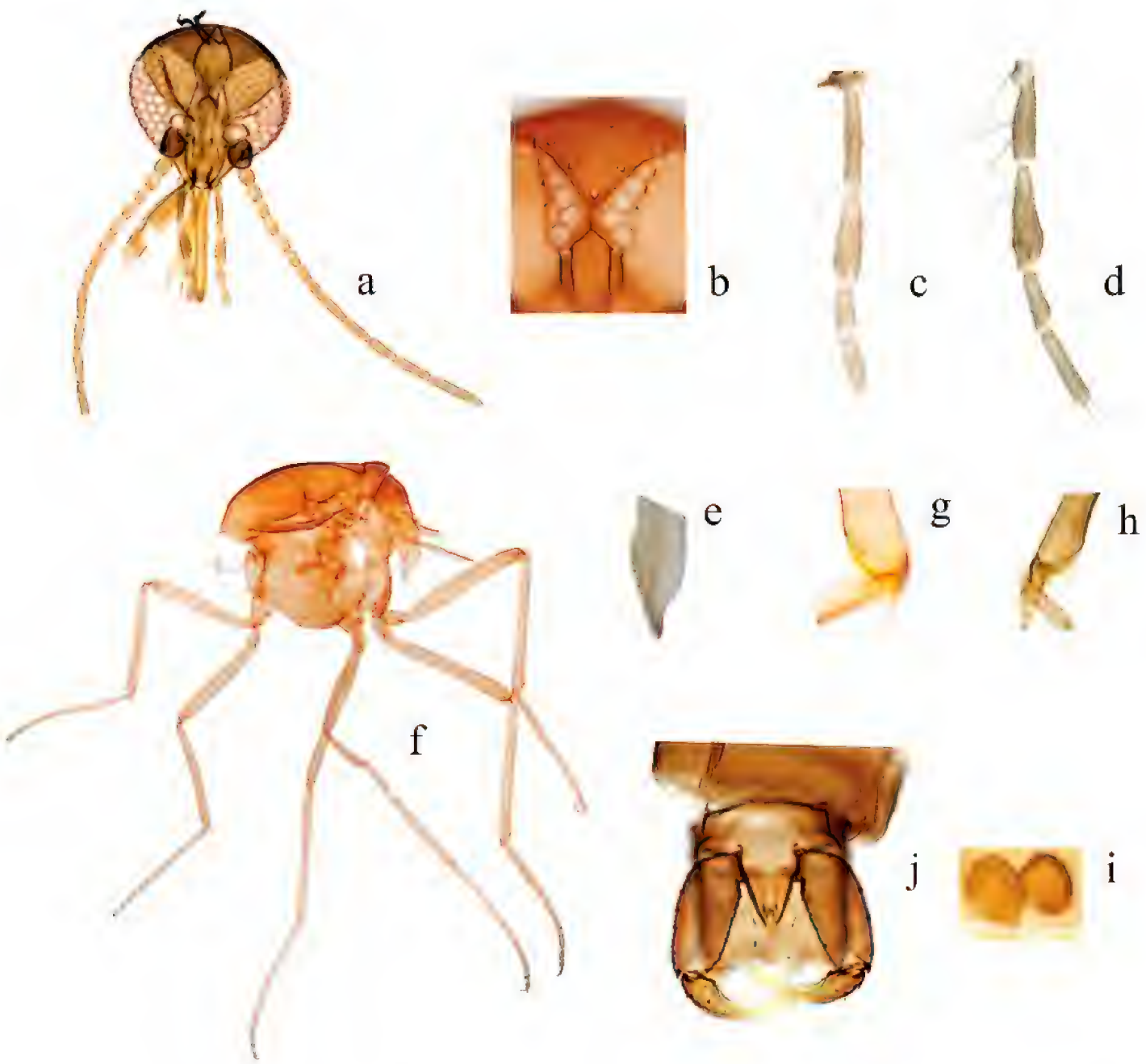

Figure 2. a–j *Culicoides* (*A.*) *fenggangensis* sp. n. **a** Head, anterior view **b** Eye contiguous, anterior view **c** Left palpus, anterior view **d** Right palpus, anterior view **e** Mandibular teeth **f** Thorax and legs, lateral view **g** Apex of hind tibia and base of first tarsomere, posterior view. **h** Apex of hind tibia and base of first tarsomere, posterior view. **i** Spermathecae **j** Genitalia, ventral view (Female: **a–c, e–i**; Male: **d, j**).

necks with 2.5–7.5 (n = 3) μm; third slender, elongate rudimentary spermatheca, length 20.0–25.0 (n = 3) μm.

Male. Similar to female with usual sexual differences. Sensilla coeloconica on flagellomeres 1, 11–13; AR 0.87 (n = 1); PR 3.11 (n = 1). Wing with pattern of pale spots as in

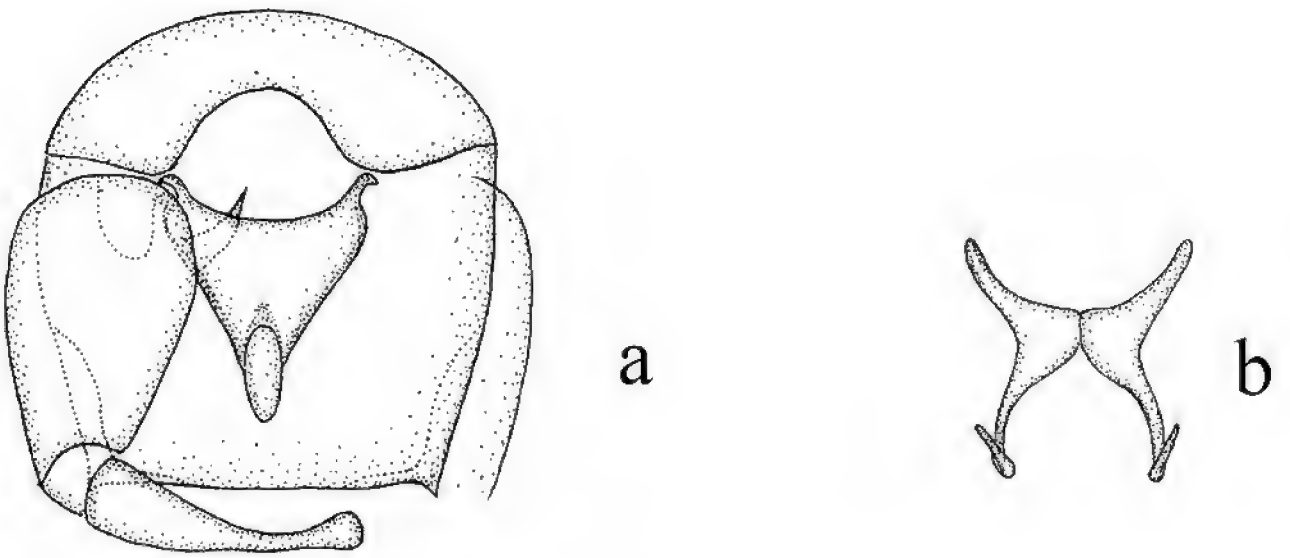

Figure 3. *Culicoides* (*A.*) *fenggangensis* sp. n. **a** Genitalia and aedeagus (parameres absent), ventral view **b** parameres, ventral view.

Table 2. TR and F-T of all legs of *C. fenggangensis* sp. n. (♂).

Leg	TR	F-T
Foreleg	2.67	95 : 92 : 56: 21 : 15 : 8 : 9
Midleg	1.94	115 : 112 : 64 : 33 : 16 : 8 : 9
Hindleg	1.49	117 : 117 : 55 : 37 : 19 : 9 : 10

Fig. 1b, wing length 1.58 (n = 1), width 0.55 (n = 1); CR 0.57 (n = 1). TR and F-T of legs are given as Table 2. Genitalia (Fig. 2j): 9th tergite squarish, distal portion flat with short, conical processes at apicolateral. Ninth sternite with broad, deep, semicircle caudomedian excavation. Gonocoxite twice as long as broad, sclerotized; gonostylus tapering distally, distal portion curved. Parameres (Fig. 3b) separate, contiguous in midportions; each with moderately long, slender basal arm, swollen at base, stem long, slightly curved near base; apical portion tapered, elongate, abruptly bent without lateral fringe of spicules. Aedeagus (Fig. 3a) nearly triangle, basal arms short, unciform, tapering toward end, basal arch low, extending to 1/5 of total length, distal process 1/6 total length, long ovoid process at apex.

Type material. Holotype female, Chongxin village, Yong'an town, Fenggang county, Zunyi city, Guizhou province, China (28°06'31.49"N, 107°35'57.94"E), 12. IV. 2016, alt. 908m, Qiongqiong Chang col. Paratypes: 2 males and 3 females, same data as holotype.

Distribution. China (Guizhou Province).

Etymology. This species is named in tribute to Fenggang county, where the specimens were collected.

Taxonomic discussion

Culicoides (*Avaritia*) *fenggangensis* sp. n. is very similar to *C.* (*A.*) *comparis* Liu & Yu, 2005 and *C.* (*A.*) *dentiformis* McDonald & Lu, 1972 based on the interfacetal hairs

on the eyes and sensilla coeloconica on the flagellomeres. *C. fenggangensis* sp. n. can be distinguished from these two congeners by the number and distribution of pale spots on the wing (cell m_2 with two and three pale spots respectively in *C. dentiformis* and *C. comparis*) (Yu et al. 2005), elongate and cylindrical third palpus segment (third palpus segment is swollen in *C. comparis* and *C. dentiformis*). Females of *C. fenggangensis* sp. n. have a different wing size (wing length 1.33 mm and width 0.63 mm in *C. comparis* and wing length 1.78 mm and width 0.76 mm in *C. dentiformis*), distribution of the heavy macrotrichia on the wing (respectively distal 4/5 and 1/4 of the wing in *C. comparis* and *C. dentiformis*), they have a more slender 3rd palpus segment compared to the most species of subgenus *Avaritia* (only 12 species PR > 3.2), PR 3.2–3.75 (respectively PR 2.27 and 2.5 in *C. comparis* and *C. dentiformis*), different size of spermathecae (measuring 45.0 × 40.0 μm in *C. comparis* and 60.0 × 45.0 μm in *C. dentiformis*). Because male of *C. comparis* is unknown, the new species will only compare with *C. dentiformis*. Males of *C. fenggangensis* sp. n. have a different shape and structure of genitalia, with two lateral processes on the distal portion of ninth tergite (without lateral process in *C. dentiformis*), parameres apical portion tapered and abruptly bent (linear in *C. dentiformis*), long ovoid process at apex of aedeagus (diamond-shape process in *C. dentiformis*). Therefore, the distinctive features to separate *C. fenggangensis* sp. n. from others are cell m_1 and m_2 with 2 and 4 pale spots respectively.

The male of *C. fenggangensis* keys to C. dentiformis in Yu et al. (2005) where it may be distinguished by the presence of conical apicolateral processes on tergite 9 which are absent in *C. dentiformis*. The female of *C. fenggangensis* keys to the couplet with *C. dentiformis* and *C. comparis* in Yu et al. (2005) where it may be distinguished by the presence of 4 pale spots in cell m_2 which are absent in *C. dentiformis* and *C. comparis*.

The biogeographical territory of China spans the Palaearctic and Oriental Regions, which results in a rich diversity of biting midge species. The species of the subgenus *Culicoides* (*Avaritia*) are distributed in most provinces of China, except Qinghai and Ningxia. There are 15 species distributed in the Palaearctic Region, accounting for 26.3% of the total (*C. abchazicus*, *C. actoni*, *C. albifascia*, *C. chiopterus*, *C. comparis*, *C. incertus*, *C. longirostris*, *C. nielamensis*, *C. nigritus*, *C. obsoletus*, *C. peregrinus*, *C. scoticus*, *C. sinanoensis*, *C. tainanus*, *C. wandashanensis*). There are 49 species present in the Oriental Region, accounting for 86.0% of the total (*C. actoni*, *C. albifascia*, *C. bawanglingensis*, *C. brevipalpis*, *C. brevitarsis*, *C. bubalus*, *C. clavipalpis*, *C. conaensis*, *C. dentiformis*, *C. elongates*, *C. filicinus*, *C. gaponus*, *C. holcus*, *C. hui*, *C. longirostris*, *C. imicola*, *C. innoxius*, *C. insignipennis*, *C. iphthimus*, *C. jacobsoni*, *C. kepongensis*, *C. kinabaluensis*, *C. lansangensis*, *C. lengi*, *C. liui*, *C. malayae*, *C. mamaensis*, *C. motoensis*, *C. nujiangensis*, *C. obsoletus*, *C. orestes*, *C. orientalis*, *C. palauensis*, *C. pastus*, *C. pelius*, *C. peregrinus*, *C. qionghaiensis*, *C. ruiliensis*, *C. sinanoensis*, *C. suiyangensis*, *C. sumatrae*, *C. suzukii*, *C. tainanus*, *C. tibetensis*, *C. trimaculatus*, *C. wadai*, *C. yamii*, *C. yuchihensis*, *C. fenggangensis*). Finally, there are seven species present in both Regions, accounting for 12.3% of the total. This geographical distribution of biting midges in China is consistent with the distribution of other animals (Yan and Yu 1998).

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References

Borkent A (2005) The biting midges, the Ceratopogonidae (Diptera). In: Marquardt W, Kondratieff BC, Moore CG, Freier JE, Hagedorn HH, Black WC, James AA, Hemingway J, Higgs S (Eds) Biology of disease vectors. Second edition, London, 113–126.

Borkent A (2016) World species of biting midges (Diptera: Ceratopogonidae). http://wwx.inhs.illinois.edu/files/4514/6410/0252/CeratopogonidaeCatalog.pdf

Chu FI (1977) New species and records of *Culicoides* (Diptera: Ceratopogonidae) from Tibet China. Acta Entomologica Sinica 20: 99–105.

Chu FI, Liu SC (1978) A taxonomic study of the genus *Culicoides* (Diptera: Ceratopogonidae) of Yunan, with descriptions of five new species. Acta Entomologica Sinica 21: 79–90.

Das Gupta SK (1962a) Some *Culicoides* of Calcutta and the neighbouring areas. Science and Culture 28: 537–539.

Das Gupta SK (1962b) *Culicoides* (Dipt., Ceratopogonidae) from suburbs of Calcutta. Entomologist's Monthly Magazine 98: 253–254.

Das Gupta SK (1963) Report on a collection of Sikkim *Culicoides* (Diptera: Ceratopogonidae). Proceedings of the Zoological Society (Calcutta) 16: 33–43.

Delfinado MD (1961) The Philippine biting midges of the genus *Culicoides* (Diptera: Ceratopogonidae). Fieldiana Zoology 33: 627–675. https://doi.org/10.5962/bhl.title.2814

Downes JA, Kettle DS (1952) Descriptions of three species of *Culicoides* Latreille (Diptera: Ceratopogonidae) new to science, together with notes on and a revised key to the British species of the *pulicaris* and *obsoletus* groups. Proceedings of the Royal Entomological Society of London (B) 21: 61–78. https://doi.org/10.1111/j.1365-3113.1952.tb01053.x

Dzhafarov SM (1964) Blood–sucking midges (Diptera, Heleidae) of the Transcaucasus. In: Dzhafarov SM (Ed.) Akademija Nauk Azerbaidzanskoi SSR, Instituta Zoologichesky, 414 pp.

Fei SH, Lee TS (1984) Description of a new species of *Culicoides* from China (Diptera: Ceratopogonidae). Acta Entomologica Sinica 27: 345–347.

Fox I (1955) A catalogue of the bloodsucking midges of the Americas (*Culicoides*, *Leptoconops* and *Lasiohelea*) with keys to the subgenera and Nearctic species, a geographic index and bibliography. Journal of Agriculture of the University of Puerto Rico 39: 214–285.

Gibbens N (2012) Schmallenberg virus: a novel viral disease in northern Europe. Veterinary Record 170: 58. https://doi.org/10.1136/vr.e292

Gornostaeva RM, Gachegova TA (1972) A new species of midges (Diptera: Ceratopogonidae) *Culicoides filicinus*, sp. n., from Western Sayans. Parazitologiya 6: 522–530.

Han XJ, Li XF, Chang QQ, Hou XH (2017) Description of a new species of *Forcipomyia* (*Euprojoannisia*) Brèthes, 1914 (Diptera: Ceratopogonidae) and a key to Chinese species of the subgenus. Entomologica Fennica 28: 1–6.

Hou XH, Han XJ, Lv B, Jiang XH (2014) A new species of biting midge of the genus *Culicoides* (Diptera: Ceratopogonidae) from China. Florida Entomologist 97: 98–99. https://doi.org/10.1653/024.097.0113

Howarth FG (1985) Biosystematics of the *Culicoides* of Laos (Diptera: Ceratopogonidae). International Journal of Entomology 27: 1–96.

Kieffer JJ (1910) Etude sur les chironomides des Indes Orientales, avec description de quelques nouvelles especes d'Egypte. Memoirs of the Indian Museum 2: 181–242.

Kieffer JJ (1913) Chironomidae *et* Cecidomyidae. In: Alluaud CA, Jeannel R (Eds) Voyage de Ch. Alluaud *et* R. Jeannelen Afriqueorientale (1911–1912). Résultats scientifiques. Diptera (= Vol. 5), 1–43, Paris, 351 pp.

Kieffer JJ (1916) Tendipedidae (Dipt.). Supplementa Entomologica 5: 114–117.

Kieffer JJ (1917) Chironomides d'Australie conservés au Musée National Hongrois de Budapest. Annales Historico–Naturales Musei Nationalis Hungarici 15: 175–228.

Kieffer JJ (1921) Chironomides des Philippines et de Formose. Philippine Journal of Science 18: 557–593.

Kitaoka S (1973) Descriptions of four new species and the hitherto unknown males of four species of the *Culicoides* (Diptera, Ceratopogonidae) from Amami-Oshima, Japan. National Institute of Animal Health Quarterly 13: 211–219.

Kitaoka S (1980) Six new species and males of some species of Japanese *Culicoides* (Diptera: Ceratopogonidae). National Institute of Animal Health Quarterly 20: 11–22.

Lee TS (1978) Diptera: Biting midges. Fasc. 13. In: Lee TS (Ed.) Economic Insect Fauna of China. Science Press, Beijing, 124 pp.

Lee TS (1979) Biting midges of Tibet, China (Diptera: Ceratopogonidae). Acta Entomologica Sinica 22: 98–107.

Lee TS (1980) *Culicoides* of Yunnan Province, China (Diptera: Eratopogonidae). Acta Zootaxonomica Sinica 5: 85–88.

Lee TS (1988) Diptera: Ceratopogonidae (II). Fasc. 38. In: Lee TS (Ed.) Economic Insect Fauna of China. Science Press, Beijing, 127 pp.

Lien JC, Lin CC, Weng MH (1998) A revision of the genus *Culicoides* in Taiwan. Part III. Subgenera *Culicoides* Latreille 1809, *Haemophoructus* Macfie 1925 and *Monoculicoides* Khalaf 1954 (Diptera, Ceratopogonidae). Journal of Taiwan Museum 51: 33–70.

Liu GP, Cao YC, Ren QM, Wang F, Wang X, Chen JY (2011) Bloodsucking midges from 5 provinces and autonomous region in China. Chinese Journal of Hygienic Insecticides & Equipment 17(5): 385–386.

Liu GP, Deng CY (2000) A new species of *Culicoides* and newly found male of *Culicoides pelius* Liu *et* Yu (Diptera: Ceratopogonidae) from Tibet, China. Chinese Journal of Vector Biology and Control 11: 245–247.

Liu JH (1990) Description of *Culicoides* (*Avaritia*) *nujiangensis* sp. nov. (Diptera: Ceratopogonidae). In: Yu YX (Ed.) Contributions to Blood-sucking Dipteran Insects. Shanghai Scientific & Technical Publishers, Shanghai, 59–61 plates.

Liu KN, Yu YX (1990) Four new species of *Culicoides* in Cuona, Xizang, China (Diptera: Ceratopogonidae). In: Yu YX (Ed.) Contributions to Blood-sucking Dipteran Insects. Shanghai Scientific & Technical Publishers, Shanghai, 19–26 plates.

Macfie JWS (1932) Some new or little–known Ceratopogonidae. Annals and Magazine of Natural History. Annals and Magazine of Natural History 10: 485–499. https://doi.org/10.1080/00222933208673523

Macfie JWS (1934) Report on a collection of Ceratopogonidae from Malaya. Annals of Tropical Medicine and Parasitology 28: 177–194, 279–293. https://doi.org/10.1080/00034983.1934.11684809

Macfie JWS (1937a) Notes on Ceratopogonidae (Diptera). Proceedings of the Royal Entomological Society of London (B) 6: 111–118. https://doi.org/10.1111/j.1365-3113.1937.tb00451.x

Macfie JWS (1937b) Three new species of *Culicoides* (Diptera, Ceratopogonidae) from Malaya. Annals of Tropical Medicine and Parasitology 31: 469–472. https://doi.org/10.1080/00034983.1937.11685005

McDonald JL, Lu LC (1972) Female *Culicoides* of Taiwan with description of new species (Diptera, Ceratopogonidae). Journal of Medical Entomology 9: 396–417. https://doi.org/10.1093/jmedent/9.5.396

Meigen JW (1818) Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. Vol. 1. Aachen, 333 pp. [1–11 plates]

Meigen JW (1830) Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. Vol. 6. Aachen, 401 pp. [55–66 plates]

Mellor PS, Boorman J, Baylis M (2000) *Culicoides* biting midges: their role as arbovirus vectors. Annual Review of Entomology 45: 307–340. https://doi.org/10.1146/annurev.ento.45.1.307

Mukerji S (1931) On a new species of *Culicoides* (*Culicoides clavipalpis* sp. nov.), with notes on the morphology of the mouth–parts and male terminalia of an Indian *Culicoides*. Indian Journal of Medical Research 18: 1051–1058.

Qu FY, Wang XY (1994) Descriptions of three new species and one new record of biting midges from southern Tibet, China (Diptera: Ceratopogonidae). Acta Entomologica Sinica 37: 486–493.

Santarém MCA, Trindade RL, Silva TN, Castellón EG, Patiu CAM, Felippe-Bauer ML (2014) New Neotropical *Culicoides* and redescription of *Culicoides reticulatus* Lutz (Diptera: Ceratopogonidae. Zootaxa 3795: 255–274. https://doi.org/10.11646/zootaxa.3795.3.2

Sen P, Das Gupta SK (1959) Studies on Indian *Culicoides* (Ceratopogonidae: Diptera). Annals of the Entomological Society of America 52: 617–630. https://doi.org/10.1093/aesa/52.5.617

Smith ROA (1929) Two species of *Culicoides* which feed on man. Indian Journal of Medical Research 17: 255–257.

Tokunaga M (1937) Sandflies (Ceratopogonidae, Diptera) from Japan. Tenthredo 1(3): 233–338.

Tokunaga M (1959) New Guinea biting midges (Diptera: Ceratopogonidae). Pacific Insects 1: 177–314.

Tokunaga M, Murachi EK (1959) Diptera: Ceratopogonidae. Insects of Micronesia 12: 103–434.

Velthuis AG, Saatkamp HW, Mourits MC, de Koeijer AA, Elbers AR (2010) Financial consequences of the Dutch bluetongue serotype 8 epidemics of 2006 and 2007. Preventive Veterinary Medicine 93: 294–304. https://doi.org/10.1016/j.prevetmed.2009.11.007

Wang CC, Chen XH, Tan RQ, Yu YX (2012) Two new species of *Culicoides* from Mt. Bawangling, Hainan, China (Diptera: Ceratopogonidae). Sichuan Journal of Zoology 31: 283–284.

Wang CM, Liu GP (1999) Sucking–blood midges and description of one new species of Heilongjiang Province in China (Diptera: Ceratopogonidae). Chinese Journal of Vector Biology and Control 10: 325–329.

Wirth WW, Hubert AA (1961) New species and records Taiwan *Culicoides* (Diptera: Ceratopogonidae). Pacific Insects 3: 11–26.

Wirth WW, Hubert AA (1989) The *Culicoides* of Southeast Asia (Diptera: Ceratopogonidae). Memoirs of the American Entomological Institute 44: 1–508.

Yan ZC, Yu YX (1998) Geographical distribution of blood-sucking midge communities. Zoological Research 19: 175–176.

Yu YX (1982) Chapter III. The identification of important biting midges of China. In: Lu BL (Ed.) Manual of Important Chinese Insect Vectors of Animal Disease, People's Health Publishing House, Beijing, 178–224, 945–951.

Yu YX (1988) Descriptions of new species of Ceratopogonidae (Diptera) in China. China Public Health Supplement 2: 127–140.

Yu YX, Liu KN (1990) Eight new species of *Culicoides* from China (Diptera: Ceratopogonidae). In: Yu YX (Ed.) Contributions to Blood-sucking Dipteran Insects. Shanghai Scientific & Technical Publishers, Shanghai, 1–13.

Yu YX, Liu JH, Liu GP, Liu ZJ, Hao BS, Yan G, Zhao TS (2005) Ceratopogonidae of China (Insecta, Diptera). Military Medical Science Press, Beijing, 1699 pp.

Zhang SN, Chang JH, Han MH, Lv JH, Wu SQ (2015) The research progress of bluetongue disease. Heilongjiang Animal Science and Veterinary Medicine 10: 57–60.

Zhang SN, Lv JH, Chang JH, Han MH, Liu K, Hai Y, Liu W, Wu SQ (2014) The epidemiological survey of bluetongue disease in Inner Mongolia in 2013. Chinese Journal of Preventive Veterinary Medicine 36: 759–762.

Zhou JC, Lee TS (1984) Two new species of *Culicoides* from China (Diptera: Ceratopogonidae). Acta Entomologica Sinica 27: 221–225.